

[54] **CdO-THO₂-FREE, HIGHLY REFRACTIVE OPTICAL GLASS**
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[52] U.S. Cl. **501/75; 501/76; 501/78; 501/901**

[58] Field of Search **501/75, 76, 78, 901**

[56] **References Cited**

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[57] **ABSTRACT**

CdO- and ThO-free, highly refractive optical glass having a refractive index of 1.85–2.05 and an Abbe index of 25–43, characterized by the following composition (in percent by weight):

| | |
|---|---------|
| SiO ₂ | 5–15 |
| B ₂ O ₃ | 2.5–8 |
| SiO ₂ + B ₂ O ₃ | 7–23 |
| SiO ₂ /B ₂ O ₃ | 1.3–2.1 |
| La ₂ O ₃ | 43–56 |
| Gd ₂ O ₃ | 0–14 |
| La ₂ O ₃ + Gd ₂ O ₃ | 43–60 |
| ZrO ₂ | 3–10 |
| Nb ₂ O ₅ | 0–15 |
| Ta ₂ O ₅ | 0–20 |
| Nb ₂ O ₅ + Ta ₂ O ₅ | 11–22 |

5 Claims, No Drawings

CDO-THO₂-FREE, HIGHLY REFRACTIVE OPTICAL GLASS

TECHNICAL FIELD OF THE INVENTION

The present invention relates to highly and maximally refractive optical glasses with a high Abbe index and to the manufacture of optical glasses with previously unattained refractive indexes of up to 2.05 and Abbe indexes of >25.

BACKGROUND OF THE INVENTION

Japanese published patent application No. 79/133,506 describes glasses having refractive indexes of 1.90-1.95 and similar Abbe values as described in the present invention; however, refractive values of only up to 1.95 can be achieved and these values only if a considerable amount of GeO₂ is employed, which is very expensive.

Glasses having refractive values of up to 1.95 and similar Abbe indexes are also described in Japanese published patent application 79/90,218; however, these familiar glasses contain either expensive GeO₂ or are not sufficiently stable towards devitrification.

DISCLOSURE OF THE INVENTION

The present invention relates to highly and maximally refractive optical glasses with a high Abbe index and to the manufacture of optical glasses with refractive indexes of up to 2.05 and Abbe indexes of greater than 25.

One very important characteristic of the present invention is the surprisingly high ratio of SiO₂/B₂O₃, which lies between 1.3 and 2.1 in accordance with the

TABLE

| EXAMPLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|--------|--------|--------|-----------------|-----------------|--------|--------|--------|--------------------------------|--------------------------------|--------|
| SiO ₂ | 10.80 | 5.40 | 7.10 | 10.90 | 7.35 | 10.35 | 7.75 | 7.45 | 12.70 | 14.55 | 7.40 |
| B ₂ O ₃ | 6.35 | 3.00 | 4.40 | 6.55 | 4.35 | 5.80 | 5.85 | 4.25 | 6.90 | 7.10 | 4.20 |
| La ₂ O ₃ | 54.85 | 49.45 | 47.90 | 47.75 | 43.80 | 50.10 | 55.30 | 54.25 | 45.65 | 46.30 | 53.50 |
| ZrO ₂ | 8.50 | 5.75 | 5.35 | 5.80 | 6.20 | 9.60 | 8.40 | 3.65 | 7.60 | 7.05 | 7.50 |
| Nb ₂ O ₅ | 4.35 | 8.55 | 8.35 | 7.10 | 5.40 | 6.50 | 9.70 | 9.60 | | 11.60 | 9.47 |
| Ta ₂ O ₅ | 13.50 | 9.45 | 12.55 | 8.35 | 7.65 | 10.50 | 11.00 | 10.90 | 16.35 | | 10.75 |
| PbO | 1.00 | 11.95 | 1.75 | 2.45 | 2.25 | 4.70 | 1.30 | 3.60 | | 0.75 | 3.55 |
| TiO ₂ | 0.65 | 6.45 | 12.60 | 0.80 | 0.75 | | 0.70 | 6.30 | | 0.40 | 3.65 |
| | | | | WO ₃ | WO ₃ | Zno | | | Gd ₂ O ₃ | Gd ₂ O ₃ | |
| | | | | 10.30 | 22.25 | 2.45 | | | 10.80 | 12.25 | |
| nd | 1.9111 | 2.0488 | 2.0373 | 1.9189 | 1.9712 | 1.9255 | 1.9594 | 2.0430 | 1.8630 | 1.8780 | 1.9940 |
| vd | 38.50 | 27.10 | 26.75 | 34.50 | 30.75 | 35.60 | 35.00 | 30.10 | 42.10 | 38.20 | 31.40 |
| SiO ₂ / B ₂ O ₃ | 1.70 | 1.8 | 1.61 | 1.66 | 1.69 | 1.78 | 1.32 | 1.75 | 1.84 | 2.05 | 1.76 |

invention. Most previously known glasses in this elevated position in the nd-, vd-diagram have required formulas in which the B₂O₃ component was greater than the SiO₂ component. For example, the maximum SiO₂/B₂O₃ ratio in glasses according to DOS 26/53,581 is equal to 1. In glasses according to DAS No. 1,926,959 with nd=1.9 and vd=40, the SiO₂/B₂O₃ ratio is approximately 0.75; moreover, these glasses contain expensive GeO₂. The same holds true for glasses according to DOS 20/57,706.

Some other highly refractive optical glasses having an SiO₂/B₂O₃-ratio of ≥ 1 are described in DAS 1,061,976. All examples named therein with refractive indexes of >1.85 have La₂O₃ components of about 63 percent by weight. Such high concentrations of La₂O₃ components destabilize the glasses; additionally, these glasses must contain Al₂O₃ or Y₂O₃.

The optimum SiO₂/B₂O₃ ratio according to the invention lies between 1.6-1.9. To achieve the required

high refractive indexes of ≥ 1.86 , 43-56 percent by weight of La₂O₃ are required and, optionally, 0-14 percent by weight of Gd₂O₃, with the sum of these two components amounting to 43-60 percent by weight.

The amount of ZrO₂ is between 3-10 percent by weight. It is mandatory to have 11-22 percent by weight of the pentavalent substitute glass producers Ta₂O₅ and Nb₂O₅, whereby the component of Nb₂O₅ may be between 0-15 percent by weight and that of Ta₂O₅ between 0-20 percent by weight. Only with these high amounts of Nb₂O₅ and/or Ta₂O₅ can glasses of the required optical position be molten which are sufficiently stable to devitrification; additionally, these components increase the refractive index considerably. Additionally, PbO, (0-13 percent by weight), TiO₂ (0-13 percent by weight), WO₃ (0-23 percent by weight) and ZnO (0-3 percent by weight) can be added.

BEST MODE FOR CARRYING OUT THE INVENTION

Glasses in accordance with the present invention are produced in the following manner: The starting materials (the appropriate oxides, nitrates, and carbonates) are weighed in accordance with the formula; a small portion of refining agent, such as As₂O₃, is added in small amounts and everything is mixed well. This mixture is melted in a Pt-crucible at 1450-1550 degrees C., is clarified and homogenized well by means of an agitator. The mixture is then stirred until the casting temperature of about 1400 degrees C. is reached, and is then cast in an iron form.

The table contains 11 compositions and their optical values by way of example:

What is claimed is:

1. CdO- and ThO-free, highly refractive optical glass which are stable to devitrification and have a refractive index nd of 1.85-2.05 and an Abbe index vd of 25-43, consisting essentially of the following composition (in percent by weight):

| | |
|---|---------|
| SiO ₂ | 5-15 |
| B ₂ O ₃ | 2.5-8 |
| SiO ₂ + B ₂ O ₃ | 7-23 |
| SiO ₂ /B ₂ O ₃ | 1.6-1.9 |
| La ₂ O ₃ | 43-56 |
| Gd ₂ O ₃ | 0-14 |
| La ₂ O ₃ + Gd ₂ O ₃ | 43-60 |
| ZrO ₂ | 5-9 |
| Nb ₂ O ₅ | 0-15 |
| Ta ₂ O ₅ | 0-20 |
| Nb ₂ O ₅ + Ta ₂ O ₅ | 11-22 |

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2. Glass as claimed in claim 1, further containing 0.4-13 percent by weight of TiO₂.

3. Glass as claimed in claim 1, further containing 0.75-13 percent by weight of PbO.

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4. Glass as claimed in claim 1, further comprising 10-23 percent by weight of WO₃.

5. Glass as claimed in claim 1, further containing 1-3 percent by weight of ZnO.

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